Spatial distribution of drumlins: is it really random?

a tectonic uplift of 500m during the Quaternary (mid-Pleistocene). The East-West variation in uplift rates across the Ardennes massif and the presence of spatially uniform climatic conditions during the Quaternary afford a good opportunity to unravel several key questions regarding extrinsic controls on landscape evolution. Two hypotheses will be tested: (1) The spatial pattern of differential uplift rates that is characteristic for the Ardennes massif will be reflected in the spatial pattern of long-term erosion rates. (2) The response time of this landscape with moderate relief will be relatively long, given the low to moderate uplift rates and subdued topography.

Long term erosion rates are derived from cosmogenic nuclide analysis, more particularly from the concentration of ^{10}Be in river-borne sediment. Twenty third-order rivers were sampled. The river basins are selected to represent the characteristic dome-like spatial pattern of uplift rates of the Ardennes Massif. The mean uplift rates for the river basins were derived from recent work by Demoulin and Hallot (2009) that revised the uplift rates for this region based on studies of river terraces in the Meuse basin and deformed Tertiary planation surfaces (Demoulin and Hallot, 2009). In parallel, a morphometric analysis was performed on a 20m resolution DEM to characterize the morphology of the river valleys as well as the nearest hillslopes.

In this paper, we present cosmogenic nuclide based erosion data for 20 river basins in the Ardennes Massif. We show that slope and river channel morphology are highly variable throughout the Ardennes Massif, and that river basins in regions with higher uplift rates clearly show transient topography.

HIGH-RESOLUTION METHANE RECORDS COVERING THE HOLOCENE

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Atmospheric CH_4 records illustrate variability on numerous timescales. The longest record from the EPICA project covering the last 800kry document low CH_4 values ($\sim$400ppb) during cold portions of the glacial periods and relatively high (600-700ppb) values during warm interglacial periods. Millennial scale CH_4 fluctuations during glacial periods also appear to be tightly coupled with Dansgaard/Oeschger climate oscillations with higher CH_4 values associated with warmer interstadial periods. In contrast to this generally tight coupling, CH_4 appears to be decoupled from climate during the Holocene.

In order to better understand CH_4 variations during the Holocene, we are developing an ultra-high resolution (20-30 year) CH_4 record from the WAIS Divide core (79.467°S, 112.085°W, $\sim$20cmice/yr, -31°C). Preliminary results confirm previous measurements from other Antarctic cores with early Holocene CH4 values of 690ppb, dropping gradually to mid Holocene values of 565ppb and then climbing to early preindustrial values of $\sim$700ppb. The most striking feature of this ultra-high resolution record is the rapid CH4 "dropout" events that occur roughly every 1,000 years. The largest of these events is the 8.2ka event that is well established in our record. At WAIS, CH_4 values drop by 70ppb over $\sim$50 yrs at the start of the 8.2 ka event, before climbing gradually over the ensuing 60 years culminating in a rapid increase over the last 30 years of the record back to pre 8.2ka values (635 ppb). Our new record follows a similar record from the GISP II ice core in magnitude suggesting the interpolar CH_4 gradient remained relatively constant throughout the event. This, in turn suggests that the 8.2ka event was a global CH_4 event impacting emissions from the two hemispheres in roughly the same proportion.

SPATIAL DISTRIBUTION OF DRUMLINS: IS IT REALLY RANDOM?

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Drumlins are the most common subglacial bedform and can be observed in all landscapes formerly occupied by ice sheets. Drumlin formation, upon which there is still no agreement, is essential to fully understand the ice-bed coupling in particular and the dynamics of ice sheets in general. Despite a vast literature on drumlins, only a handful of papers focus on their spatial distribution. Do drumlins tend to aggregate in clusters or are they dispersed? Is their distribution completely random? This is a crucial aspect because some theories of their formation link drumlin distribution to the presence of obstacles or nuclei that might be expected to be randomly distributed in the landscape. Other theories (e.g. instability) favour the idea of drumlinisation as a self-organising phenomenon that tends towards the creation of a coherent spatial patterning. Thus far, papers that have analysed drumlin spatial distribution have showed mixed results, but with a preference for random distributions. However, we suggest that a robust conclusion has yet to be reached from previous studies, partly because of the relatively small sample sizes utilised and partly because of the techniques applied. This paper presents the results of a new analysis of drumlin spatial distribution based on an extensive mapping program of drumlin fields in the British Isles, North America and Scandinavia, generating a sample size of >50,000 landforms. GIS techniques were applied to a statistical study of the spatial distribution of drumlins in 100s of different drumlin fields. Analysis focused on the nearest neighbour distance between drumlins, decoupled into the two fundamental (along and across) ice flow components. Results reveal a clear spatial patterning, far from the random distribution often advocated in the literature. We further suggest a genetical relationship with ribbed moraine, which supports the concept of a subglacial bedform continuum, and crucially, a unifying theory of bedform formation.

ANALYSIS AND INTERPRETATION OF NATURAL REMANENCE DIRECTIONS AT THE UPPER OLDUVAI BOUNDARY AT LINGTAI, CHINESE LOESS PLATEAU

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In 1982, Friedrich Heller and Liu Tungsheng obtained the first complete magnetostratigraphy of the Chinese loess plateau (CLP). As more and more sections were investigated, small inconsistencies were noticed between the exact stratigraphic positions of some of the major geomagnetic polarity reversals. The question therefore arose as to how the loess and palaeosols involved actually acquired their magnetisation. Thus, although the basic magnetostratigraphy of the CLP is secure, the ability of the sediments in question to resolve features of short duration is seriously questioned. Varying local and regional environmental parameters such as sedimentation rate, wind strength, soil humidity and temperature, and vegetation may compromise the palaeomagnetic record. In an attempt to throw further light on this problem, we have studied in considerable detail the polarity transition that terminated the Olduvai Subchron in a section at Lingtai in the central CLP. We conclude that there are two independent remanence-acquisition processes—detrital and pedogenic—that create an artificially complicated apparent polarity pattern. We propose a lock-in model that is able to explain some, but by no means all, of the observations. Nevertheless, the weight of evidence indicates that it is premature to interpret many of the brief apparent polarity jumps observed throughout the CLP as real geomagnetic features.

EXPLORATION AND DEVELOPMENT OF THE CLIMATE ARCHIVE OF THE ALLAN HILLS, ANTARCTICA

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Fundamental uncertainties remain in our understanding of natural and anthropogenic climate forcing. Multi-million year records from marine sediments have hinted at possible drivers, but their relatively low resolution and lack of direct proxies for reconstructing atmospheric chemistry make deciphering the interactions between these drivers difficult. Increased resolution and direct atmospheric proxies are available in ice cores; however, the longest existing record (EPICA Dome C (EDC)) only reaches 800 ka. Extending this record will greatly aid efforts to elucidate the factors controlling climate dynamics. Obtaining a longer record is hindered by the availability of old ice. For Antarctica, glaciological models suggest that ice as old as 1.5 million years may exist near bedrock within the East Antarctica Ice Sheet, but it is yet to be confirmed. The Allan Hills blue ice area, located on